AN ANOMALY IN LUMINANCE AMPLITUDE NEAR THE MELTING POINT OF PLATINUM

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We describe an experimental study of oscillations in the temperature of platinum specimens heated by electron bombardment in a region including the melting point.

In [1], in which the specific heat of platinum was studied by the modulation method of [2], it was found that in a narrow temperature interval near the melting point there was a large increase in the amplitude of the oscillations in the luminance of the specimen. The author of [1] assumed that the reason for this is a corresponding anomalous decrease in the specific heat. The authors of [3] also observed an increase in the amplitude of the luminance oscillations but did not attribute it to the specific heat, considering it instead to be a consequence of a change in the blackness coefficient upon melting.

The phenomenon discovered in [1] is of unequestionable interest, and therefore it is desirable to study it under other experimental conditions.

In [1], the specimen (a platinum wire) was heated by passing a current through it. In this case the amplitude of the luminance oscillations was caused not only by the specific heat of the specimen, but also by its electrical resistance and coefficient of blackness. When a specimen is heated by a current, heat is generated throughout its entire thickness, while cooling takes place only at its surface. From this we may assume the possibility of overheating of interior regions and partial melting of these regions when there is a solid surface whose luminosity is recorded. Heating to the melting point results in destruction of the specimen.

We attempted to observe this phenomenon in the heating of a specimen by electron bombardment. A block diagram of the apparatus used is shown in Fig. 1. The measurements, as in [1], were made in a vacuum of $1\text{-}5\cdot10^{-5}$ mm Hg (1-6 MPa). The specimen was a segment of platinum wire 20-100 μm in diameter and 2-5 mm long, welded to the holder at one end. The free end of the specimen was heated by bombarding it with electrons accelerated by a voltage of 300-600 V. The power modulation was carried out by sinusoidally varying the accelerating voltage. The modulation factor was 0.2-2%, depending on the experiment. The light flux from the emitting area formed on the specimen was directed to a photodiode by an optical system. A two-variable plotting board was used for recording the amplitude of the oscillations in the luminance of the specimen as a function of its average luminance.

This method made it possible to observe the specimen as it passed through the melting point a number of times. Since the current through the specimen was negligibly small, the effect of resistance variation with temperature was excluded. We also excluded the possibility of overheating interior regions, since the heating took place at the surface.

It was found that the transition of the investigated portion of the specimen to the liquid state was accompanied by a sharp change in luminance. This enabled us to record the melting point in our investigation of the temperature dependence of the luminance oscillations. We found that when the average temperature of the specimen was raised slowly, there was a peak in the amplitude of the oscillations in luminance in the immediate vicinity of the melting point (Fig. 2). The amplitude increased by a factor of 5-30.

The resolution of the apparatus in our study was not so high as in [1], and we were unable to distinguish the amplitude peak from the start of melting on the temperature axis. When the specimen was heated more rapidly, the peak was much smaller or was absent; this may be a result of sluggishness in the apparatus used.

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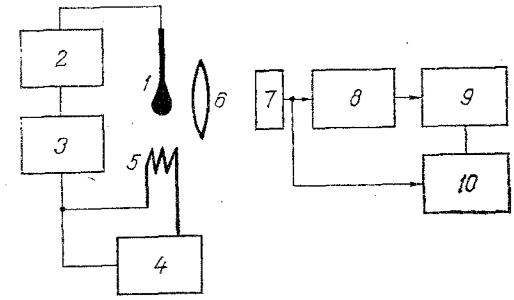

Fig. 1

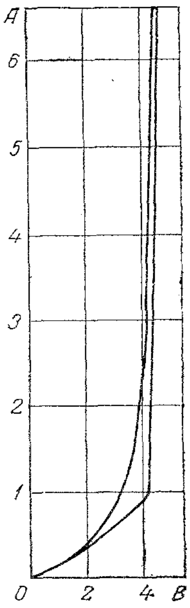

Fig. 2

Fig. 1. Block diagram of the apparatus for heating by electron bombardment and recording of the temperature oscillations in the specimen: 1) specimen; 2) modulator; 3) source of accelerating voltage; 4) source of filament voltage; 5) electron source (filament wire); 6) optical system; 7) photodiode; 8) amplifier; 9) rectifier; 10) two-variable recorder (plotting board).

Fig. 2. Variation of the amplitude of the luminance oscillations as a function of the average luminance of platinum (in relative units): A) amplitude of the luminance oscillations (modulus); B) average luminance.

The observations made enable us to conclude that under conditions of electron-bombardment heating of the specimen, there is a peak in the luminance oscillations, as in [1]. However, our data do not enable us to establish whether the peak we observed is the result of a variation in specific heat, as assumed by the author of [1], or the result of a variation in the coefficient of blackness upon melting, as assumed in [3].

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